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Abstract

The present studies aimed to analyse the modulatory effect of distressing facial expressions on attention processing. The attentional blink (AB) paradigm is one of the most widely used paradigms for studying temporal attention, and is increasingly applied to study the temporal dynamics of emotion processing. The aims of this study were to investigate how identifying fear and pain facial expressions (Study 1) and fear and anger facial expressions (Study 2) would influence the detection of subsequent stimuli presented within short time intervals, and to assess the moderating influence of alexithymia and affectivity on this effect. It has been suggested that high alexithymia scorers need more attentional resources to process distressing facial expressions and that negative affectivity increases the AB. We showed that fear, anger and pain produced an AB and that alexithymia moderated it such that difficulty in describing feelings (Study 1) and externally oriented thinking (Study 2) were ...

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Amplification of attentional blink by distress-related facial expressions: Relationships with alexithymia and affectivity

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The present studies aimed to analyse the modulatory effect of distressing facial expressions on attention processing. The attentional blink (AB) paradigm is one of the most widely used paradigms for studying temporal attention, and is increasingly applied to study the temporal dynamics of emotion processing. The aims of this study were to investigate how identifying fear and pain facial expressions (Study 1) and fear and anger facial expressions (Study 2) would influence the detection of subsequent stimuli presented within short time intervals, and to assess the moderating influence of alexithymia and affectivity on this effect. It has been suggested that high alexithymia scorers need more attentional resources to process distressing facial expressions and that negative affectivity increases the AB. We showed that fear, anger and pain produced an AB and that alexithymia moderated it such that difficulty in describing feelings (Study 1) and externally oriented thinking (Study 2) were associated with higher interference after the processing of fear *and* anger at short time presentations. These studies provide evidence that distressing facial expressions modulate the attentional processing at short time intervals and that alexithymia influences the early attentional processing of fear and anger expressions. Controlling for state affect did not change these conclusions.

Keywords: Attentional blink; Alexithymia; Fear; Anger; Pain.

Attentional blink phenomenon

The attention blink (AB) paradigm refers to how the detection of a first target (T1) impairs the identification of a second target (T2) with a stimulus onset asynchrony (SOA) of approximately 200–500 milliseconds in a rapid serial visual presentation (RSVP; Olivers & Meeter, 2008; Potter, Staub, & O'Connor, 2002). AB is one of the most validated and the most used paradigm to study temporal attention.

Different theoretical frameworks have been proposed to account for the AB effect. According to inhibitory models, the stimuli that follow T1 are inhibited as a result of possible featural confusion during T1 identification (gating theory, Raymond, Shapiro, & Arnell, 1992) or in order to not interfere with T1 and T1 + 1 processing (boost and bounce theory, Olivers & Meeter, 2008). The capacity limitation models suggest that T1 detection grabs attentional resources, leading to insufficient resources remaining to process T2 (e.g., bottleneck theories; Potter et al., 2002). For a review, see Dux and Marois (2009).

The AB paradigm is increasingly used to study the temporal dynamics of emotion processing in healthy and clinical populations with emotion-processing biases/deficits, such as anxiety (e.g., de Jong, Koster, van Wees, & Martens, 2010). The aim of this study is to contribute to this growing literature by studying AB with three different distressing T1 emotional facial expressions (EFEs): fear, anger and pain, as well as to

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assess the moderating effect of alexithymia, a personality factor characterized by emotion-processing deficits.

Attentional blink and distressing T1

The processing of EFEs has been intensively investigated in attention studies. In this context, a substantial body of studies suggested an automatic capture of distress-relevant EFEs (i.e., fear and anger) (e.g., Ohman, Lundqvist, & Esteves, 2001). The preferential allocation of attentional resources to threat-related stimuli may be directly related to self-preservation, and more specifically to the necessity to respond accurately and rapidly to the threat. In the context of temporal attention, sad faces T1 produce higher blink of neutral T2 relative to happy T1 at 0 and 100 milliseconds (Srivastava & Srinivasan, 2010). In relation to anger, de Jong et al. (2010) showed a blink for neutral T2 that followed anger faces with an SOA of 118 milliseconds. Stein, Zwickel, Ritter, Kitzmantel, and Schneider (2009) showed that the explicit (elaborated) processing of fear but not of neutral expressions T1 (Vs. gender decision and no decision) impaired the identification of neutral T2 presented with a SOA of 134 milliseconds. These studies thus revealed that the processing of distressing faces impairs the detection of subsequent neutral stimuli presented within a short time interval.

In addition to the normative amplification of AB by distressing EFEs, dispositional emotion-processing deficits may further modulate the AB effect. Alexithymia is one such relevant moderator.

Alexithymia

Alexithymia is a personality construct that involves difficulties in identifying feelings, in describing feelings, and an externally oriented thinking style (Bagby, Parker, & Taylor, 1994). This construct was initially introduced to describe clinical patients with so-called psychosomatic diseases who experienced difficulties describing their emotions and who presented impoverished mental representations of their emotional states. This may explain the high prevalence of alexithymia in somatic and mental disorders (see Lumley, Neely, & Burger, 2007).

In relation to the processing of EFEs, there is evidence of inefficient processing of distressing EFEs in high alexithymia scorers (HA) relative to low scorers (LA). Within signal-detection paradigms, HA showed impaired detection of negative EFEs presented during short presentation times (33 milliseconds, Prkachin, Casey, & Prkachin, 2009); 1 second, Parker, Prkachin, & Prkachin, 2005) but not at longer presentation times (3 seconds, Parker et al., 2005) or without time constraints (Prkachin et al., 2009). These effects at short presentation times were driven by two alexithymia factors: difficulties in describing feelings (Parker et al., 2005) and externally oriented thinking (Prkachin et al., 2009). At an attentional level, based on visual event-related potentials, HA showed a delayed attentional orientation (delayed N2b/P3a components) towards deviant angry facial expressions during an oddball paradigm (Vermeulen, Luminet, Cordovil de Sousa, & Campanella, 2008). Moreover, HA need greater attentional resources at an early processing stage (i.e., increased P2 component) to process emotional pictures in an oddball paradigm (Franz, Schaefer, Schneider, Sitte, & Bachor, 2004). Taken together, these studies suggest that HA may require more attentional resources when processing distressing/negative emotions. As a result, it might be that the processing of subsequent stimuli presented within a short time interval may be particularly impaired.

No studies to date have investigated such temporal consequences of emotion-processing deficits in alexithymia. The AB paradigm opens the possibility to investigate this issue.

In summary, the objectives of the current studies are: (1) to replicate the impairing effect of distressing EFEs (i.e., anger and fear) on AB, (2) to test if HA would show even longer AB than LA (3) to include pain EFEs (in order to extend past studies). In addressing the three main research objectives, we also controlled for the effects of positive and negative affects. This was necessary because they modulate AB (i.e., positive affect reduces AB, negative affect amplifies AB, Vermeulen, 2010) and are associated with alexithymia (greater negative affect and lower positive affect among HA; Konrath, Grynberg, Corneille, Hammig, & Luminet, 2011).

We hypothesized that exposure to pain faces may increase an AB under very short SOAs, especially among HA. Pain is a complex emotion as pain expressions may quickly evoke an avoidance response to the presence of an external potential danger (that actually hurts the other individual; e.g., Yamada & Decety, 2009), but they may also lead to approach-related empathic responses among observers (Botvinick et al., 2005). Thus, similar to fear and anger expressions, pain expressions may evoke a potential threat. In relation to alexithymia, Moriguchi et al. (2007) showed that when people are instructed to process bodily parts in pain situations, HA present higher activation in neural regions associated with responses of distress (the anterior cingular cortex [ACC] and the insula, Singer et al., 2004).

STUDY 1

The aim of the first study was to assess if fear and pain expressions impair the processing of neutral expressions at short time intervals, and if alexithymia moderates this effect.

Method

Participants

Forty-one healthy volunteers participated in the study (11 males; $M_{\text{age}} = 21.52$ years; $SD_{\text{age}} = 1.87$). They were recruited through posted advertisements on the campus of the Catholic University of Louvain, in Louvain-la-Neuve and were paid 12.50 Euros for taking part in the study.

Materials

Stimuli. T1 stimuli represented six actors displaying fear, pain, happy and neutral expressions (24 stimuli) (Simon, Craig, Gosselin, Belin, & Rainville, 2008). For the distractors, we selected 36 neutral faces from another database (Lundqvist, Flykt, & Öhman, 1998). T2 stimuli were 62 indoor and 62 outdoor scenes selected from the Internet.

Questionnaires. The 20-item Toronto Alexithymia Scale; *TAS-20* (Bagby et al., 1994) measures three dimensions of the alexithymia construct: difficulty identifying feelings (DIF; 7 items), difficulty describing feelings (DDF; 5 items) and externally oriented thinking (EOT; 8 items). The TAS-20 total score has an internal consistency of .73 (Loas, Otmani, Verrier, Fremaux, & Marchand, 1996).

The Bermond-Vorst Alexithymia Questionnaire version B; BVAQ (Vorst & Bermond, 2001) measures five dimensions (4 items per dimension): difficulties verbalizing emotional experience (*Verbalizing*), poor fantasy life (*Fantasizing*), poor insight into one's emotional experiences (*Identifying*), lack of emotional excitability (*Emotionalizing*), and difficulties reflecting on one's own emotional states (*Analysing*). The BVAQ total score has an internal consistency of .85 (Vorst & Bermond, 2001). For these questionnaires, participants have to indicate their agreement on 5-point Likert-type scales. Higher scores on these scales indicate a higher level of alexithymia.[1]

The Positive Affectivity Negative Affectivity Schedule; PANAS (Watson, Clark, & Tellegen, 1988) is a 20-item scale which consists of 10 positive (*Interested*) and 10 negative (*Guilty*) affective states whose intensity is rated on 5-point Likert-type scales. In this study, we used the state version. The negative affectivity and the positive affectivity have respectively an internal consistency of .85 and .89 (Watson et al., 1988).

Design and procedure

Participants were instructed to judge facial emotional expressions and indoor and outdoor scenes. Each trial (see Figure 1 for an illustration of a typical AB trial) started with the presentation on a computer screen, via Eprime 1.0 program, of a fixation cross (500 milliseconds) directly followed by the RSVP of distractors and targets. The presentation duration was set to 67 milliseconds/item. The SOA between the two targets was set to three different Lags: 134 milliseconds (Lag2: one distractor between T1 and T2), 335 milliseconds (Lag5: four distractors between T1 and T2) and 737 milliseconds (Lag11: ten distractors between T1 and T2). The number of distractors before T1 ranged between 3 and 15, and there were three distractors after T2. The position of T2 was thus held constant. After each trial, participants were instructed to identify among three possible labels the emotion displayed by T1, followed by the decision on the indoor or outdoor location of the scene (T2). Participants had to indicate their responses by pressing keyboard buttons and were not informed of their responses' accuracy.

There was a total of three blocks of 72 trials each (fixed 24 trials per lag) (block 1: neutral, pain and fear; block 2: neutral, happiness and fear; block 3: neutral, pain and happiness). All participants processed all three blocks in that order, but only the results from the critical block 1 were considered in this study.[2] For each lag of each block, 24 T1 were randomly selected among 36 pictures (each actor's picture of each expression was doubled) and 24 T2 were randomly selected among 62 indoor and 62 outdoor scenes. Each combination of 3 T1* 2 T2 can thus occur with equal probability.

All stimuli in the RSVP series were grey-scaled photographs (16.4 cm × 16.4 cm) presented against a white background (see Stein et al., 2009). Distractors

[1]Three BVAQ subfactors correspond to the TAS-20 subfactors (i.e., Identifying = DIF; Verbalizing = DDF; Analyzing = EOT).

[2]This is because our primary interest in this research was to compare effects of fear and pain expressions relative to neutral expressions. Randomizing block order may have contaminated measures in our most critical block (i.e., the first block) because of learning, habituation and carry-over effects (the results can be made available upon request). Relative to T1, participants were less accurate (for both block 2 and 3) in identifying T1 at Lag 11 than at Lag 2 and Lag 5. Furthermore, in block 3, participants were more accurate in identifying neutral T1 faces than happiness and pain faces. Relative to T2, There were no AB effects on block 2 and 3. There was only an effect of Lag in block 2 which showed that performances at Lag 5 were significantly lower than performances at Lag 11 and Lag 2. We argue that the absence of blink at these blocks might result from the absence of randomized presentation of blocks. As already explained, we decided to start all experimental sessions with the block ''fear-pain-neutral'' because our primary interest here was in comparing effects of fear and pain expressions and we wanted to avoid habituation and carry-over effects resulting from the earlier processing of less-relevant blocks. Consistent with what we anticipated, this habituation effect likely explains the increase in T1 accuracy and the absence of blink in block 2 and block 3.

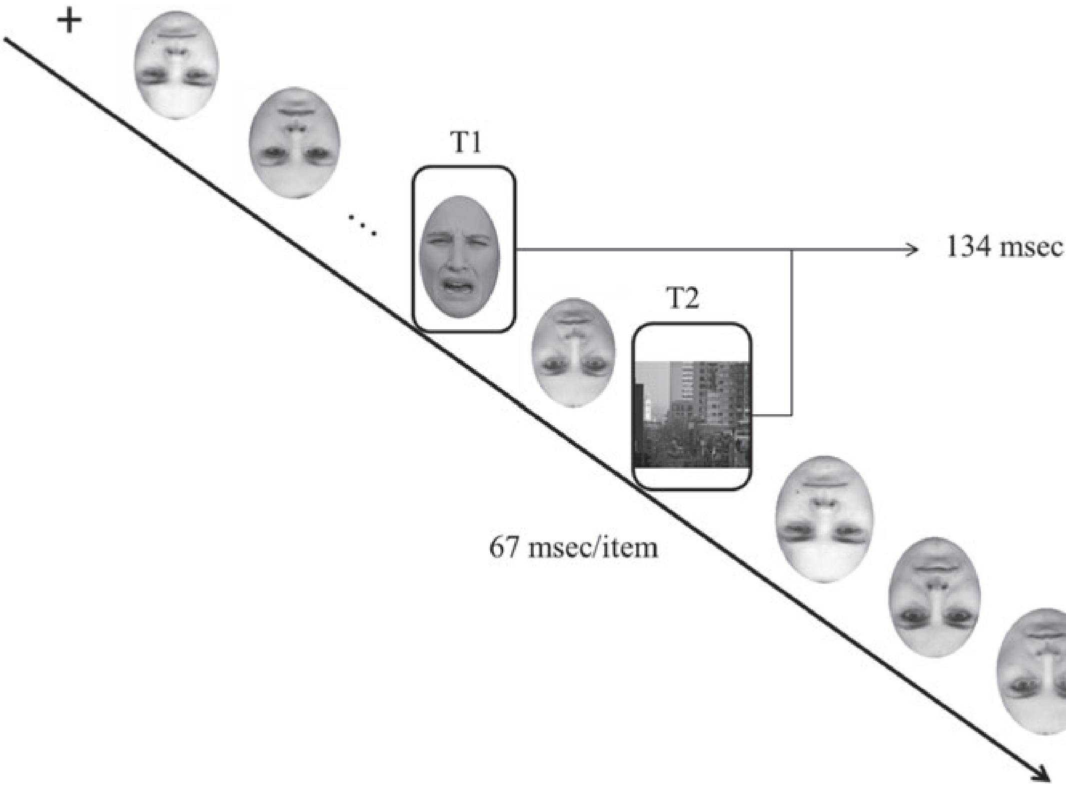

Figure 1. Schematic overview of a typical trial.
Note. Within a rapid serial visual presentation (RSVP), T1 (facial expression of pain, fear, happiness or neutral) and T2 (indoor or outdoor scene) are presented one at a time for 67 milliseconds amongst a series of rotated neutral faces (distractors).

were neutral facial expressions that were inverted (rotated 180°, see de Jong et al., 2010). Participants completed the PANAS before the task and the alexithymia questionnaires after it.

Statistics

The statistical analyses were performed with SPSS 17.0. Mean percentages of correct identification of T1 and T2 (contingent upon T1 being correctly identified) were computed. The significance level was set at $p < .05$.

Results

Descriptive data

The means, standard deviations and the range of alexithymia scores are described in Table 1.

Influence of emotional expression on correct identification of T1

Block 1. Repeated measures showed a significant main effect of Emotion on accurate identification of T1, $F(2, 80) = 26.65$; $p < .001$, $\eta^2 = .40$: participants were more accurate in identifying neutral T1 faces than in identifying fear ($p < .001$) and pain ($p < .001$) faces, whereas accuracy in identifying fear and pain faces did not differ ($p < .27$; Table 2). The effect of Lag was also significant, $F(2, 80) = 10.45$; $p < .001$, $\eta^2 = .21$: participants were less accurate in identifying T1 at Lag5 than at Lag2 ($p < .03$). Performances on trials at Lag11 did not significantly differ from performances at Lag5 and Lag2 ($ps < .30$). The interaction between Emotion and Lag was significant, $F(4, 160) = 10.00$; $p < .001$, $\eta^2 = .20$: there was a effect of Emotion at Lag2, $F(2, 80) = 3.37$; $p < .04$, at Lag5, $F(2, 80) = 16.29$; $p < .001$, and at Lag11, $F(2, 80) = 38.94$; $p < .001$. At each lag, the identification was better for neutral than fear ($ps < .02$) and pain ($ps < .001$; except for Lag2; $p = .09$) expressions. Finally, T1 identification did not differ between pain and fear T1 trials at all Lags ($ps < .62$) except at Lag11 ($p < .03$).

Influence of emotional expression on correct identification of T2

Block 1. Repeated measures showed a main effect of Lag, $F(2, 80) = 5.47$; $p < .01$; $\eta^2 = .12$: participants were more accurate in identifying T2 at Lag11 than

TABLE 1
Descriptive data of alexithymia scores in Study 1 and Study 2

		Study 1		*Study 2*	
		Mean (SD)	*Range*	*Mean* (SD)	*Range*
TAS-20	DIF	14.44 (5.37)	7–27	15.07 (4.81)	7–26
	DDF	14.68 (5.72)	5–25	12.65 (4.44)	5–24
	EOT	17.22 (4.63)	8–28	16.05 (3.90)	9–27
	TOTAL[a]	46.34 (12.72)	27–71	43.78 (9.57)	26–65
BVAQ	Verbalizing	12.00 (4.04)	5–19	10.35 (3.57)	4–10
	Fantasizing	7.51 (3.70)	4–17	8.06 (3.09)	4–17
	Identifying	8.63 (2.90)	4–17	9.27 (2.60)	4–16
	Emotionalizing	9.39 (2.95)	5–16	8.26 (2.14)	4–14
	Analysing	8.34 (3.17)	4–16	7.06 (2.35)	4–14

Note. Total = Total alexithymia score; DIF = difficulties identifying feelings; DDF = difficulties describing feelings; EOT = externally oriented thinking; BVAQ = Bermond and Vorst Alexithymia Questionnaire.
[a]With the cutoff of Taylor, Bagby, & Parker (1997), there are 25 LA and 8 HA in Study 1 and 57 LA and 3 HA in study 2.

TABLE 2
Descriptive data of the percentage of correct identification (*SD*) of T1 and T2 identification (block 1 from Study 1; Study 2)

	T1				*T2*			
	Lag2	*Lag5*	*Lag11*	*Mean* (SD) *per emotion*	*Lag2*	*Lag5*	*Lag11*	*Mean* (SD) *per emotion*
Study 1 (block 1)								
Neutral	81.05 (16.59)	87.19 (13.34)	88.30 (17.23)	85.21 (12.53)	94.42 (9.88)	96.89 (5.67)	94.30 (11.52)	95.20 (6.31)
Fear	70.67 (21.75)	66.99 (25.54)	50.19 (25.74)	62.62 (20.82)	83.82 (23.85)	92.37 (13.28)	95.37 (10.99)	90.47 (10.38)
Pain	72.47 (25.54)	65.01 (22.40)	60.49 (26.25)	65.99 (20.42)	89.97 (14.95)	89.71 (17.09)	95.01 (9.93)	91.28 (8.72)
Mean (*SD*) per lag	74.73 (14.74)	73.06 (14.10)	66.33 (16.63)	71.37 (13.38)	89.13 (10.66)	93.00 (9.17)	94.89 (6.93)	92.34 (6.36)
Study 2								
Neutral	84.47 (13.14)	84.48 (13.60)	83.60 (15.65)	84.18 (12.68)	96.02 (5.76)	93.62 (7.10)	94.70 (7.44)	94.78 (5.10)
Fear	73.71 (23.21)	71.00 (24.36)	63.78 (23.64)	69.50 (22.15)	92.16 (11.27)	91.63 (12.17)	95.27 (10.26)	93.02 (9.51)
Anger	57.58 (20.14)	58.07 (20.66)	52.32 (19.36)	56.06 (17.72)	89.78 (12.05)	90.77 (15.04)	93.80 (9.26)	91.45 (8.85)
Mean (*SD*) per lag	71.99 (14.22)	71.18 (14.03)	66.58 (13.79)	69.91 (13.07)	92.65 (8.25)	92.01 (8.58)	95.59 (7.03)	93.08 (6.91)

Note. T2 were contingent upon T1 being correctly identified.

at Lag5 ($p < .03$) and Lag2 ($p < .005$; Table 2 and Figure 2). Performances on trials at Lag5 and Lag2 did not significantly differ ($p < .25$). There was a main effect of Emotion, $F(2, 80) = 5.68$; $p = .005$; $\eta^2 = .12$: participants were more accurate in identifying T2 after neutral than after pain ($p < .02$) or fear ($p = .001$) faces, but did not differ significantly between fear and pain face trials ($p = .63$).

The interaction between Emotion and Lag was significant, $F(4, 160) = 2.57$; $p = .04$; $\eta^2 = .06$, and revealed an effect of Emotion at Lag2, $F(2, 80) = 4.19$; $p < .02$; $\eta^2 = .10$, and at Lag5, $F(2, 80) = 4.35$; $p < .02$; $\eta^2 = .10$, but not at Lag11 ($p < .89$). At Lag2 and Lag5, T2 identification was better after neutral than pain, Lag2: $p = .09$; Lag5: $p = .01$ and fear, Lag2: $p < .02$; Lag5: $p < .03$ expressions. T2 identification did not differ between painful and fearful T1 trials at any Lag (Lag2: $p = .18$; Lag5: $p = .33$).

Moderating impact of alexithymia on AB

We calculated indexes of the strength of the blink for each emotion for Lag2 and Lag5 of block 1. For instance, the calculation of the INDEXFEAR2 is: (LAG11Neutral minus LAG11Fear) minus (LAG2Neutral minus LAG2Fear). Thus, higher negative scores on these indexes refer to stronger AB for EFEs at Lag2 or Lag5. For these indexes, we took into account the effect of Lag on neutral expressions and the effect of emotion on Lag11.

Correlational analyses between these indexes and alexithymia revealed that INDEXFEAR2 was negatively associated with the TAS-20 factor DDF and with its corresponding factor in the BVAQ (*Verbalizing*). These results suggest that greater difficulties in describing feelings are associated with worse performance when identifying T2 within 134 milliseconds after the correct identification of fear expressions. However, when controlling for scores on the PANAS (partial correlations), these correlations

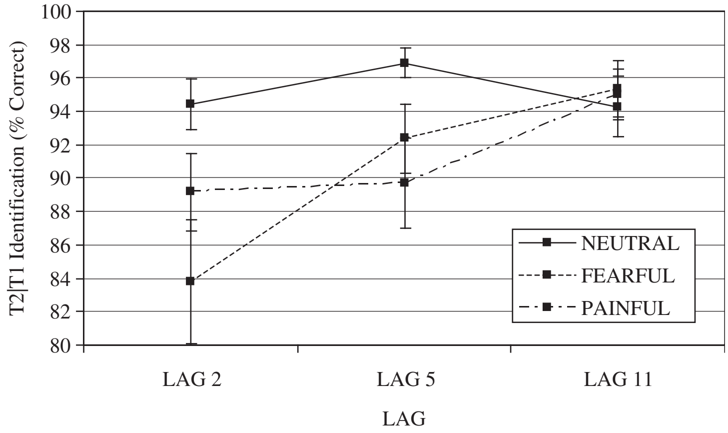

Figure 2. Mean percentage of accurate T2 identification given correct T1 identification at each Lag (Study 1). Error bars represent standard errors around the means.

were only marginally significant ($ps < .07$). There was no effect of alexithymia on T1 accuracy.

STUDY 2

Study 2 aimed to replicate the AB for fear and to see if it extends to anger faces and to assess the moderating effect of alexithymia on the AB.

Method

Participants

Sixty-eight volunteers participated in the study (14 males; $M_{age} = 21.74$ years; $SD_{age} = 2.22$). They were recruited through posted advertisements on the campus of the Catholic University of Louvain, in Louvain-la-Neuve, and were paid 8 Euros for taking part in the study.

Materials

Stimuli. T1 stimuli represented 25 actors displaying fear, anger and neutral expressions (Langner et al., 2010; Lundqvist et al., 1998). For the distractors, we selected 60 other neutral faces from the same databases. T2 stimuli and questionnaires were the same as in Study 1.

Design and procedure

The procedure was the same as in Study 1, except that there was only one block of 180 trials, with 60 trials for each Lag (Lag2; Lag5 and Lag11), among which there were 20 presentations of each type of expression (neutral, anger and fear) and that all stimuli were grey-scaled photographs (16.4 cm × 16.4 cm) presented against a grey (and not white) background. Contrary to Study 1, the faces were not cropped and distractors were neutral facial expressions that were inverted (rotated 180°).

Results

Influence of emotional expression on correct identification of T1

Repeated measures analysis showed a main effect of Emotion, $F(2, 134) = 59.41$; $p < .001$; $\eta^2 = .47$: participants were more accurate in identifying neutral than fear ($p < .001$) or anger ($p < .001$) faces (Table 2). Participants were more accurate in identifying fear than anger faces ($p < .001$). There was a main effect of Lag, $F(2, 134) = 15.10$; $p < .001$; $\eta^2 = .18$: participants were less accurate in identifying T1 at Lag11 than at Lag5 ($p < .001$) and Lag2 ($p < .001$). Performances on trials at Lag5 and Lag2 did not significantly differ ($p < .44$).

The interaction between Lag and Emotion was significant, $F(4, 268) = 4.17$; $p < .005$; $\eta^2 = .06$ and showed an effect of Emotion at Lag2, $F(2, 134) = 48.06$; $p < .001$; $\eta^2 = .42$, at Lag5, $F(2, 134) = 4\,38.59$; $p < .001$; $\eta^2 = .37$, and at Lag11, $F(2, 134) = 56.03$; $p < .001$; $\eta^2 = .46$. At each Lag, neutral expressions were better identified than fear ($p < .001$) and anger ($p < .001$) expressions. Finally, T1 identification differed between anger and fear T1 trials at all Lags ($ps < .001$).

Influence of emotional expression on correct identification of T2

Repeated measures showed a main effect of Emotion, $F(2, 134) = 7.31$; $p = .001$ $\eta^2 = .10$: participants were more accurate in identifying T2 after neutral than after anger ($p < .001$) or fear ($p < .05$) faces, but did not differ significantly between fear and anger face trials ($p = .08$; Figure 3). There was a main effect of Lag, F(2,

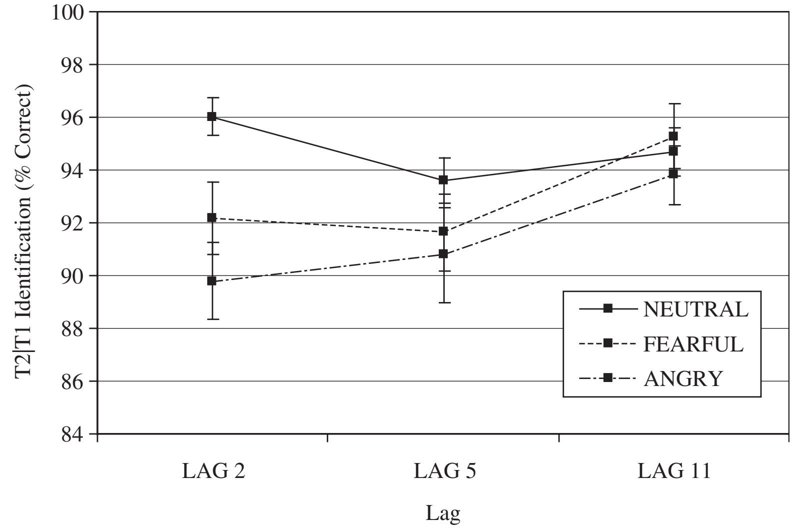

Figure 3. Mean percentage of accurate T2 identification given correct T1 identification at each Lag (Study 2). Error bars represent standard errors around the means.

134) = 5.14; $p = .01$; $\eta^2 = .07$: participants were more accurate in identifying T2 at Lag11 than at Lag5 ($p < .01$) and Lag2 ($p < .02$). Performances on trials at Lag5 and Lag2 did not significantly differ ($p < .50$).

The interaction between Lag and Emotion was significant, $F(4,\ 268) = 2.35$; $p = .055$; $\eta^2 = .03$ and revealed an effect of Emotion at Lag2, $F(2, 134) = 13.37$; $p < .001$; $\eta^2 = .27$ but not at Lag5 ($p < .30$) and Lag11 ($p < .50$). At Lag2, T2 identification was better after neutral than fear ($p = .001$) and anger ($p < .001$) expressions. Finally, T2 identification tended to differ between fear and anger T1 trials at Lag2 ($p < .06$; better performances after fear than after anger).

Moderating impact of alexithymia on AB

We calculated two indexes of the strength of the blink for respectively fear and anger emotion for Lag2 in the same way as in Study 1. Correlations analyses between these two indexes and alexithymia scores revealed that the BVAQ factor Analysing (concrete externally bound thinking style) was negatively associated with the INDEXFEAR2 and INDEXANGER2. We also showed that INDEXFEAR5 was correlated with the TAS-20 factor EOT and the BVAQ factor Fantasizing. When controlling for positive and negative affects (partial correlations), the correlations remained significant (*ps* < .05). These results suggest that higher levels of concrete externally bound thinking style is associated with less accurate T2 identification within 134 milliseconds of fear and anger T1 and within 335 milliseconds of fear T1, independently of current positive and negative affects (Table 3).[3]

GENERAL DISCUSSION

The results of these two studies indicate that relative to neutral expressions, the processing of anger, fear and pain expressions produces an AB in the identification of subsequent stimuli after a short SOA. These findings confirm that the blink is temporally constrained, as deficits were not observed outside the typical temporal window of the AB. Regarding the processing of fear and anger, our findings are in line with previous findings (de Jong et al., 2010; Stein et al. (2009) which showed that fear and anger expressions T1 impaired the identification of neutral T2.

The AB effect for distressing EFEs may result from the fact that attentional resources are preferentially allocated to threat-related stimuli (Ohman et al., 2001). These findings suggest that the threat detection system might have been activated in the participants (in both studies)

[3]Some significant correlations were found between alexithymia and T1 identification. The TAS-20 factors DIF and DDF were correlated with less accurate identification of neutral expressions (r= -.36; p<.01; r= -.32; p<.01). Furthermore the BVAQ factor Verbalizing was negatively correlated with the identification of fear (r= -.33; p=.01) and the BVAQ factor Emotionalizing was negatively correlated with the identification of fear (r= -.29; p<.03) and anger (r= -.36; p<.01). One may suggest that Lower T2 identification might thus result from interference due to poor T1 labelling abilities. Actually, although identifying and emotionalizing feelings were associated with lower T1 identification, these factors were not associated with any AB, which suggests that, at least in the present studies, the influence of alexithymia on AB is not related to T1 identification abilities. Moreover, the correct identification of T2 was analyzed on the basis of trials with correct T1 identification. Therefore, deficits related to EFEs processing among HA are most probably not related to poor labelling abilities.

TABLE 3
Pearson moment product correlations between alexithymia, positive and negative affectivity and index of attentional blink for Study 1 (block 1) and for Study 2 (partial correlations when controlling for positive and negative affectivity)

	Study 1 (block 1)				*Study 2*			
	Lag2		*Lag5*		*Lag2*		*Lag5*	
Factors	*Fear*	*Pain*	*Fear*	*Pain*	*Fear*	*Anger*	*Fear*	*Anger*
TAS-20								
DIF	.10	.20	.23	.25	.08	.00	.12	.06
DDF	−.32* (−.30¥)	−.03	−.13	.01	.16	.15	.05	.04
EOT	.04	.05	−.23	−.19	−.09	−.10	−.25* (−.26*)	−.11
TOT	−.09	.09	−.04	.04	.08	.03	−.02	.02
BVAQ								
Verbalizing	−.34* (−.30¥)	.00	−.17	−.16	.17	.25	−.14	.01
Fantasizing	−.19	−.09	−.18	−.09	−.15	−.14	−.27* (−.28*)	−.07
Identifying	−.10	−.04	−.06	.01	.10	.06	−.02	.04
Emotionalizing	−.22	−.07	−.26	−.23	−02	.10	−.04	.14
Analysing	−.15	−.10	−.27	−.15	−.34** (−.34*)	−.30* (−.31*)	−.21	−.11
Panas								
Positive affectivity	.14	.28	−.01	−.03	−.16	.04	.03	.07
Negative affectivity	.16	.28	.18	.43**	−.03	.04	.12	.14

¥ $p < .07$; * $p < .05$; ** $p < .01$.

very early. Though, it is worth noting that anger produces a blink at very short SOA (134 milliseconds), while fear and pain are associated with a blink at the same SOA but also at 335 milliseconds. It may be that anger is not processed in the same way as fear and pain expressions. These facial expressions were all presented out of a specific context, but while angry faces looking directly at the participant might not require a long thoughtful process to appear like threatening, expressions of fear and pain looking directly at the participant may be related to a more context-dependent process (e.g., ecological context). More specifically, these expressions may require a longer time and perhaps a more ''thoughtful'' process to determine if they are threatening or not. This will explain that the AB after fear and pain is present at longer SOA than anger expressions.

However, because pain expressions can signal both approach and avoidance, it may not be the threat component of pain expressions that underlie the AB in response to pain. Thus, while the threat value of fear and anger has been extensively suggested to attract attentional resources, future studies are still needed to determine whether it is the threat value of pain that attracts attention and produces an AB.

An alternative account for the AB at short time intervals after the processing of fear, anger and pain would suggest that any other negative and/or arousing facial expressions would also produce a blink. Several studies have indeed shown that arousing stimuli, such as positive/negative taboo words (Mathewson, Arnell, & Mansfield, 2008), may increase the AB.

Regardless of the specific mechanisms involved, the finding of prolonged AB among HA has clear social implications. HA may be less able to detect some relevant information during social interaction. They may show a hampered processing of visual information that follows the detection of distressing EFEs. Consequently, they risk to miss important social cues.

Moderating impact of alexithymia

In relation to alexithymia, we showed that greater difficulties describing feelings and a concrete externally bound thinking style were associated with a stronger blink after the processing of fear expressions. Furthermore, we showed that the BVAQ factor Analysing was associated with a stronger blink after the processing of anger. Thus, alexithymia is associated with stronger interference after the processing of EFEs that are mainly related to threat (i.e., fear or anger). Our prediction that alexithymia would be associated with a stronger blink in pain trials was not supported. This may be owing to the complex nature of pain expressions (e.g., avoid the threat; empathic approach). Pain mainly indicates a potential threat, however, the impact of the detection of EFEs might be stronger among HA relative to LA only when these EFEs are related to threat (i.e., fear or anger).

Several mechanisms may account for the greater blink among HA after the processing of fear *and* anger at Lag2. The first hypothesis is directly related to attentional resources. HA may be more alert after the detection of distressing stimuli. HA (participants with greater difficulties describing feelings in Study 1, and participants with a concrete way of thinking in Study 2) may thus allocate more attentional resources to these stimuli, as suggested by previous findings of HA exhibiting a delayed processing of anger expressions (Vermeulen et al., 2008) and greater demand of attentional resources to process emotionally arousing stimuli (Franz et al., 2004).

Second, we can suggest that fear and anger expressions may leave less attention to subsequent stimuli in HA because they have to regulate the negative impact of these stimuli during their appraisal. This is in line with previous findings that showed higher ACC activation in HA during fear expressions processing (e.g., Pouga, Berthoz, de Gelder, & Grezes, 2010), which was suggested to be associated with HA's tendency to ''restrict the harmful, unpleasant impact of a negative event'' (Pouga et al., 2010, p10). At a neural level, it may be that, relative to LA, HA show higher ACC activation that would mediate the AB after fearful T1. Schwabe et al. (2011) showed that higher activation in the ACC predicts greater AB after emotional T1. Therefore, it may be that HA attempt to regulate their arousal induced by fearful T1 (associated with higher ACC activation) leading to a stronger inhibition of T2 (*boost and bounce theory*) or with fewer remaining attentional resources available to process T2 (*capacity limitation theory*).

Third, it may be that rather than requiring more resources, HA might only need more time to correctly identify distressing expressions. This temporal adjustment explanation might also explain HA's impaired performances in detecting distressing EFES at short but not at long presentation times (Parker et al., 2005; Prkachin et al., 2009). Interestingly, our results are in accordance with previous studies that showed that difficulty describing feelings have been consistently implicated in the processing of negative EFEs.

Fourth, the association between greater difficulties describing feelings (but not a concrete way of thinking) and the AB after fear T1 is not significant anymore after controlling for positive and negative affects. Even if not statistically significant (the effect sizes remained practically unchanged), this effect suggests that affective states or traits should be more systematically assessed when investigating the effect of personality characterized by emotion-processing deficits on the AB.

Taken together, mechanisms other than attentional resources (decoding abilities, regulation strategy, and/or positive and negative affect) may account for HA's AB at short intervals for fear *and* anger expressions. Future studies should thus be able to disentangle these different explanations.

Limitations

Even though performance in the processing of T2 significantly decreased after emotional T1 at Lag2, the report of T2 was still high relative to what has been previously observed (de Jong et al., 2010). One explanation for this comes from the ease to process indoor and outdoor scenes. de Jong et al. (2010) presented ambiguous T2 stimuli, which may explain their relatively higher error rate. Another explanation refers to the ''pop-up'' effect: our T2 stimuli might have shown because of their featural contrasts with the other stimuli: T2 were clearly different from T1 (faces) and distractors (upside down faces), which might have made them more apparent. This is in line with a previous study (Chua, 2005), which showed that when T2 luminance contrast was high relative to distractors, the AB was weaker.

In relation to alexithymia, there were only a few individuals who were truly HA (eight in Study 1 and three in Study 2). This could explain why the alexithymia effects were not as robust as expected. Second, the effect of emotion at Lag2 was not associated with the same alexithymia subfactors in Study 1 and Study 2. We suggest that the context of experimentation (the database of EFEs, the number of different pictures per emotion, faces cropped or not) may partly explain this inconsistency. For instance, previous data showed that the association between the subfactors of alexithymia and performances at a memory task are influenced by the context (Vermeulen, Toussaint, & Luminet, 2010). These authors tested the effect of emotional music (anger or happy) during the encoding of emotional words (neutral, joy, disgust, anger) on their recognition. They showed that the correlations between memory performances for words and alexithymia subfactors differed depending on the music. Nevertheless, our findings highlight the importance of considering alexithymia factors separately rather than as a global score.

Conclusion

In conclusion, these studies thus add one significant finding to the domain of facial expressions and attention, by providing evidence for converging effects of fear, anger *and* pain perception in early attentional processes.

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